



UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION
INTERNATIONAL ATOMIC ENERGY AGENCY
INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS
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SMR/930 - 34

"Workshop on El Niño, Southern Oscillation and Monsoon"
15 - 26 July 1996

"Monsoon-ENSO Coupling"

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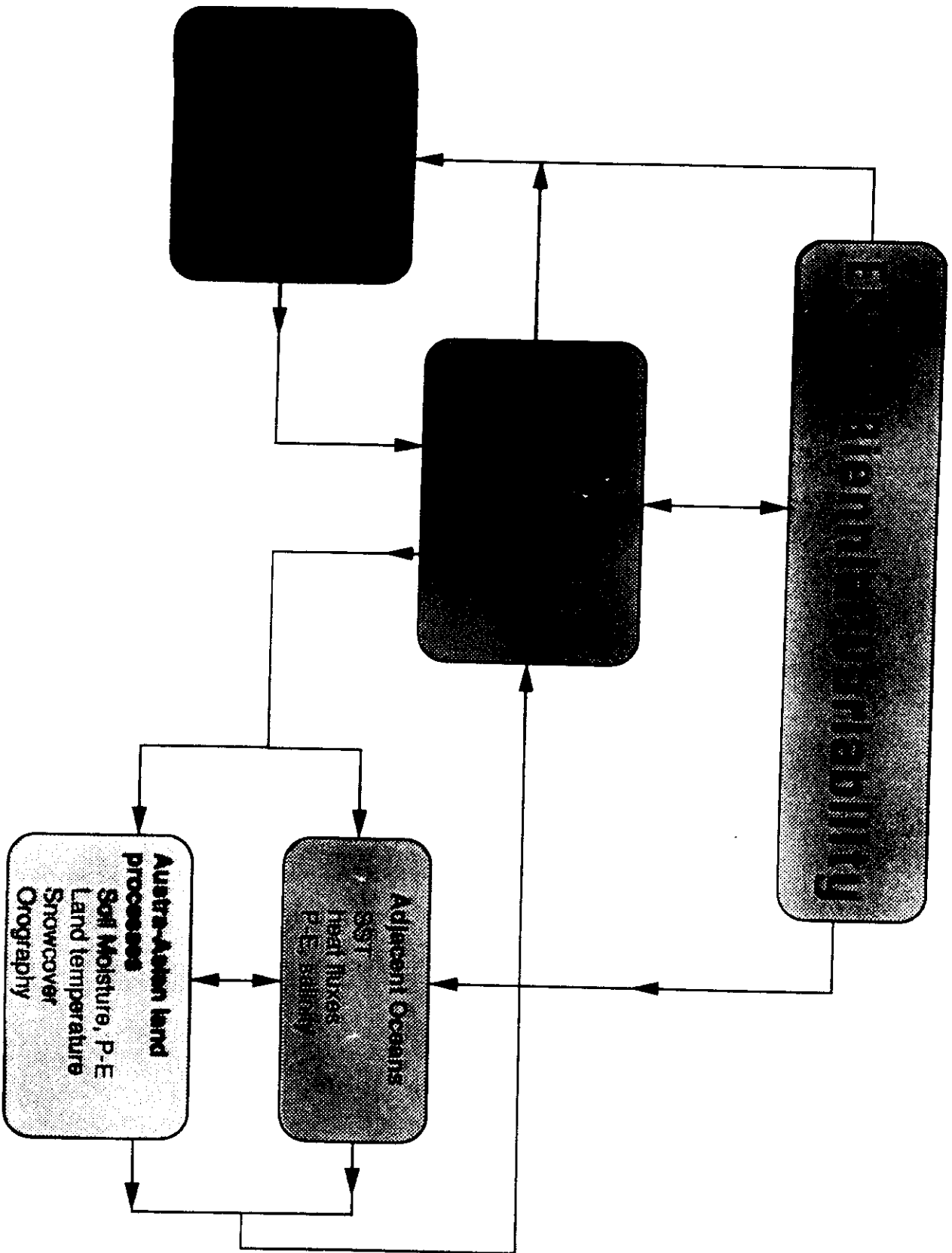
Please note: These are preliminary notes intended for internal distribution only.

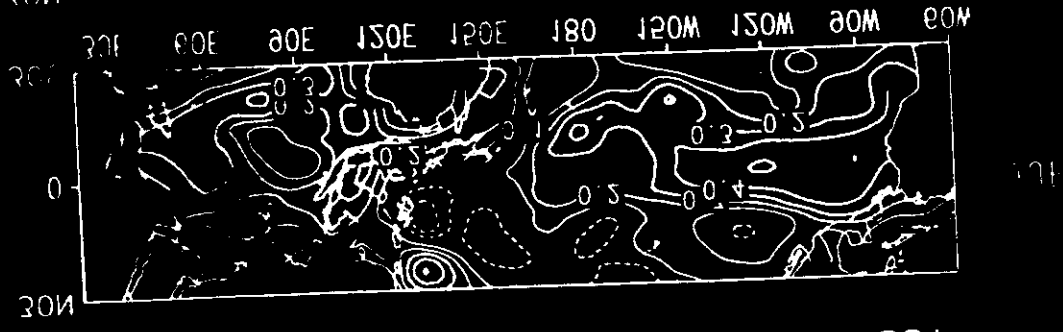
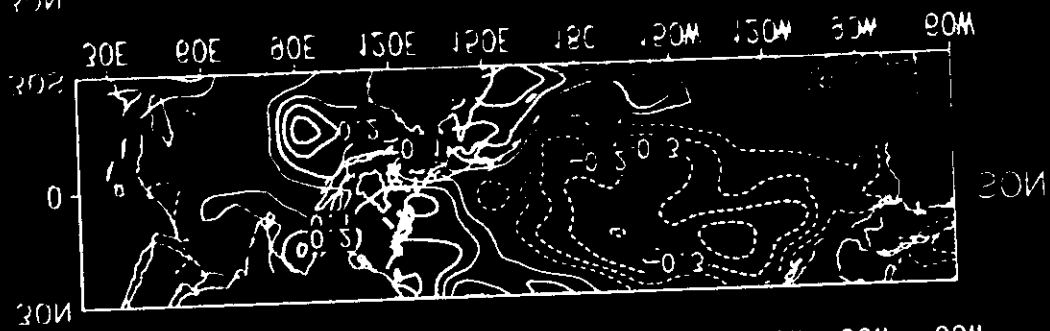
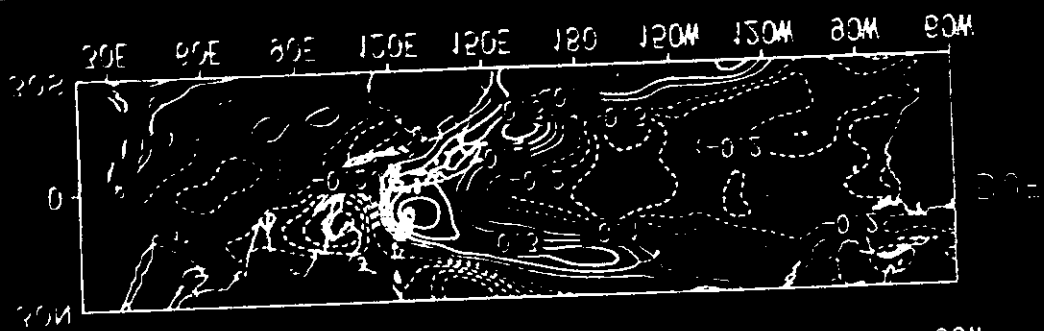
Monsoon-ENSO coupling

William K.-M. Lau

NASA/Goddard Space Flight Center

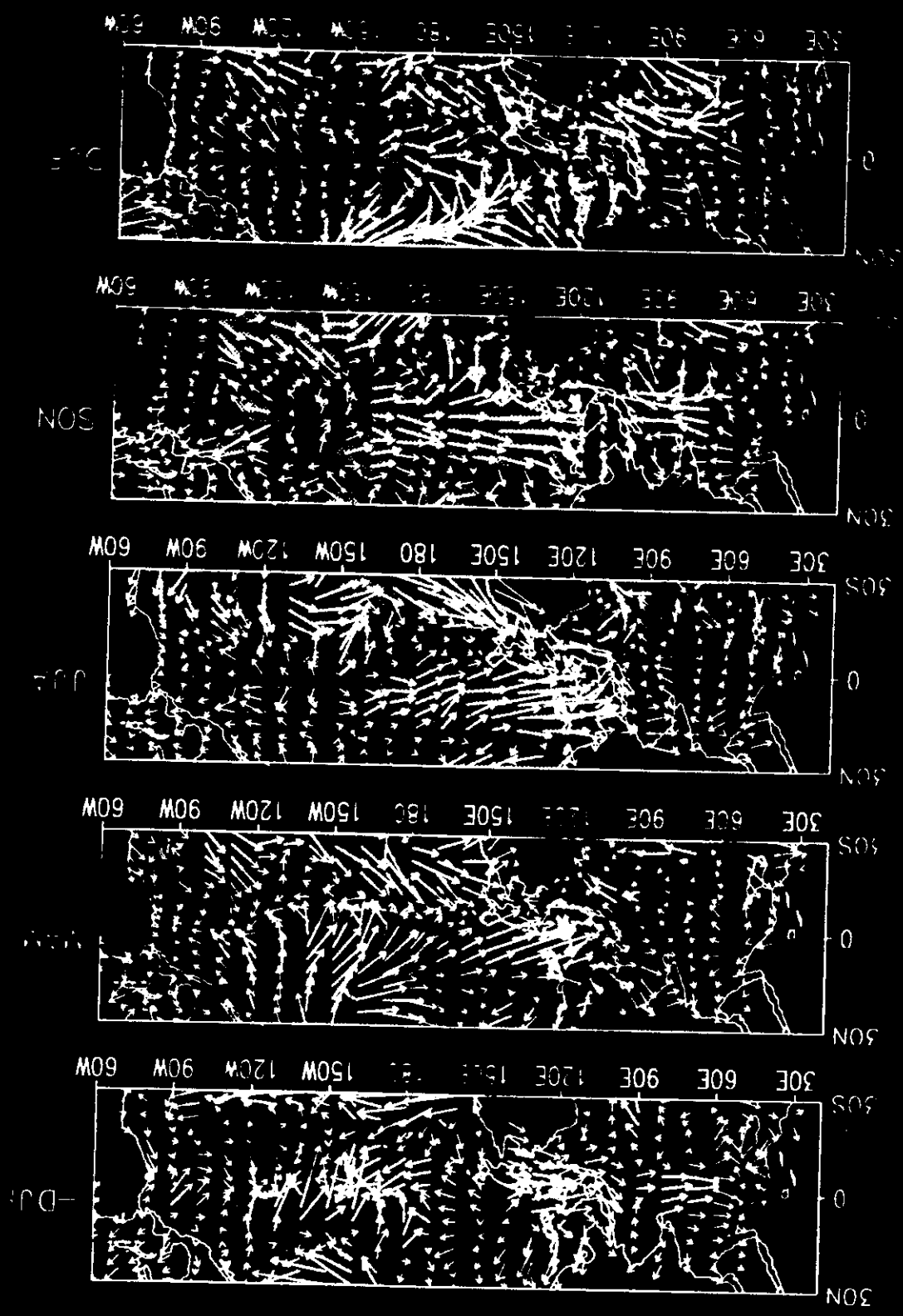
- ENSO/Biennial Variability
- Modulation of predictability
- Regional monsoon characteristics
- Inter-monsoon variability
- SST vs. land surface influence on monsoon variability



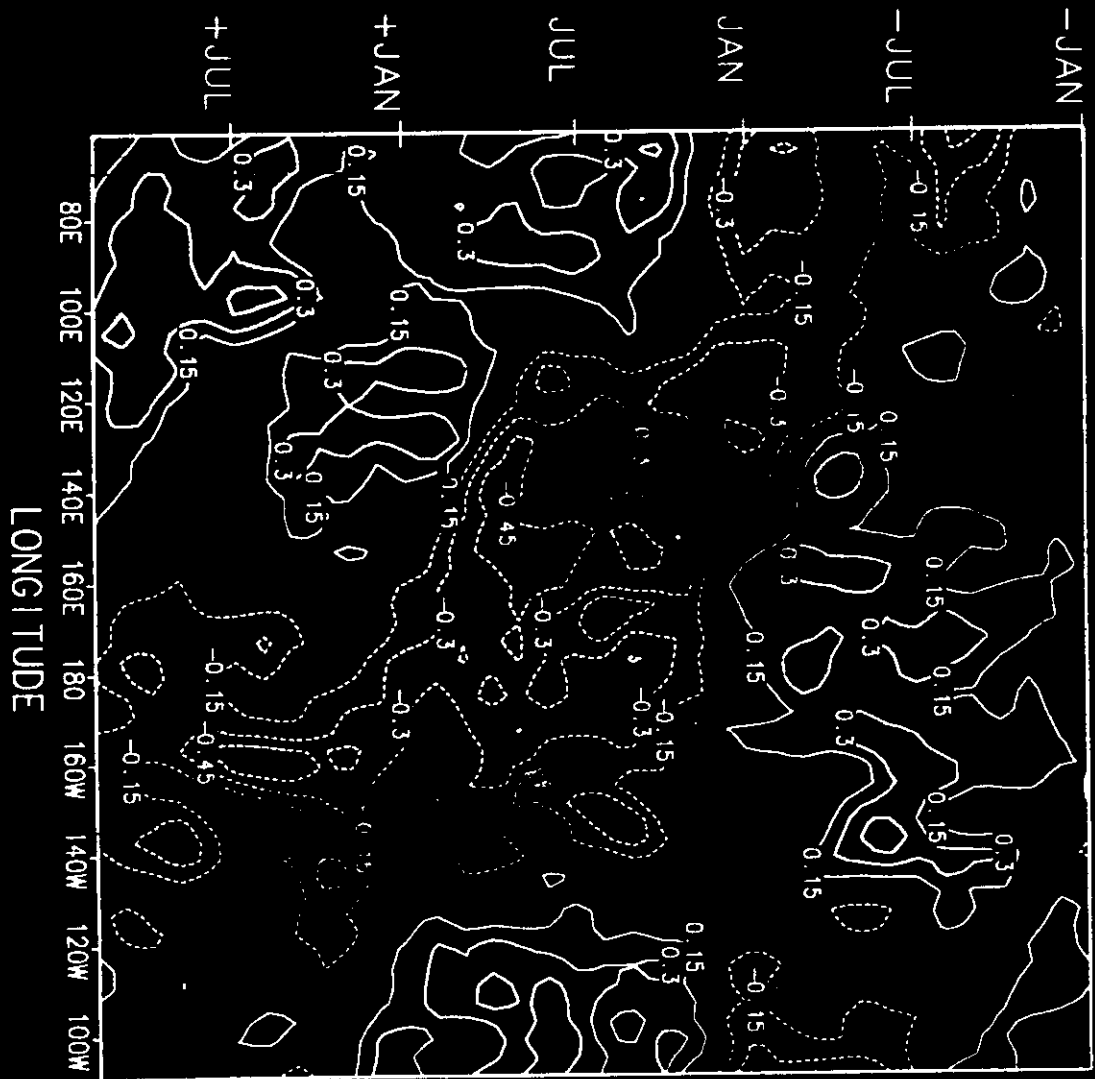


CORRELATION OF RAINFALL EOF1 AND SST

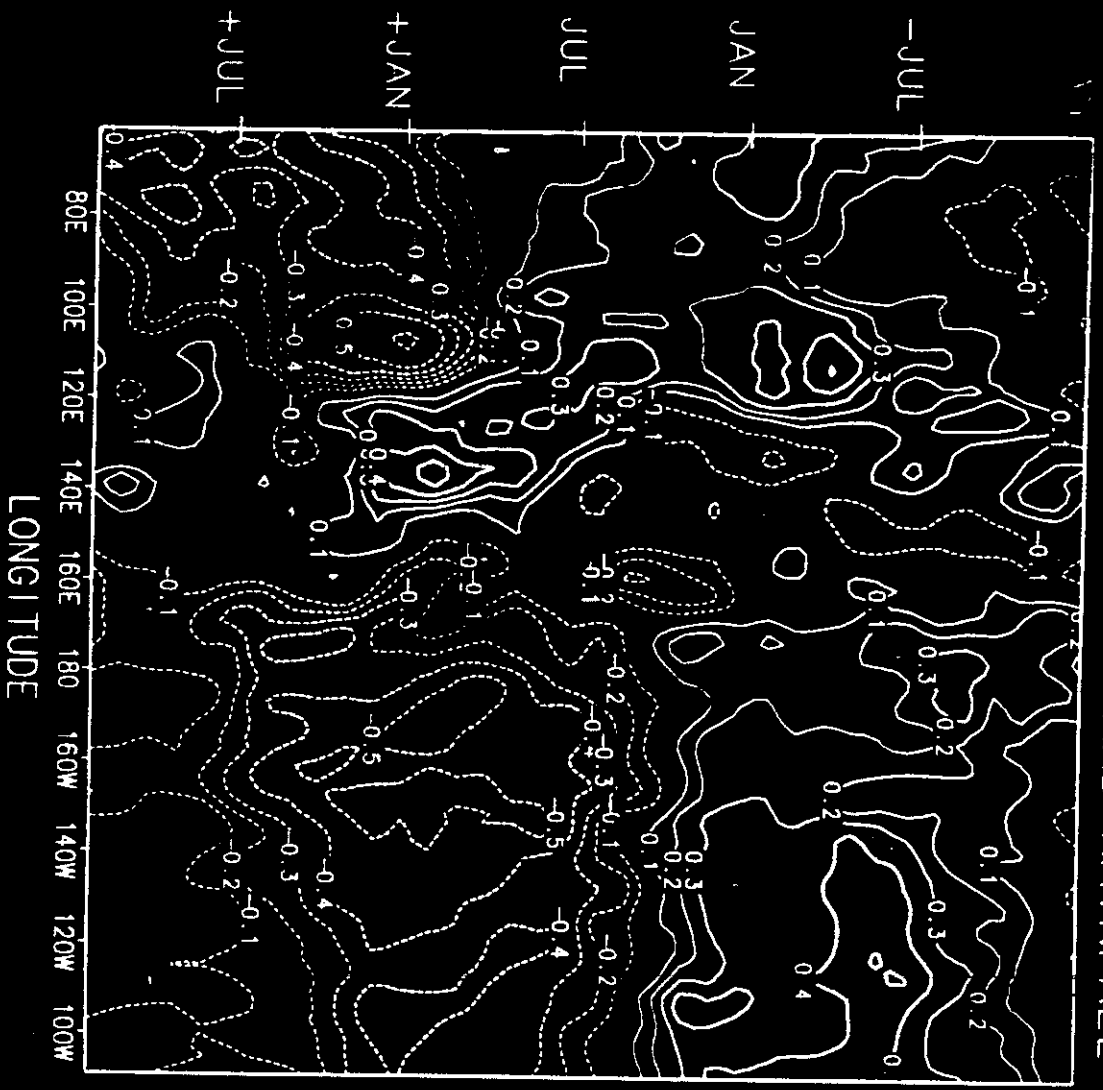
Correlation of Rainfall EOF1 and Surface Wind



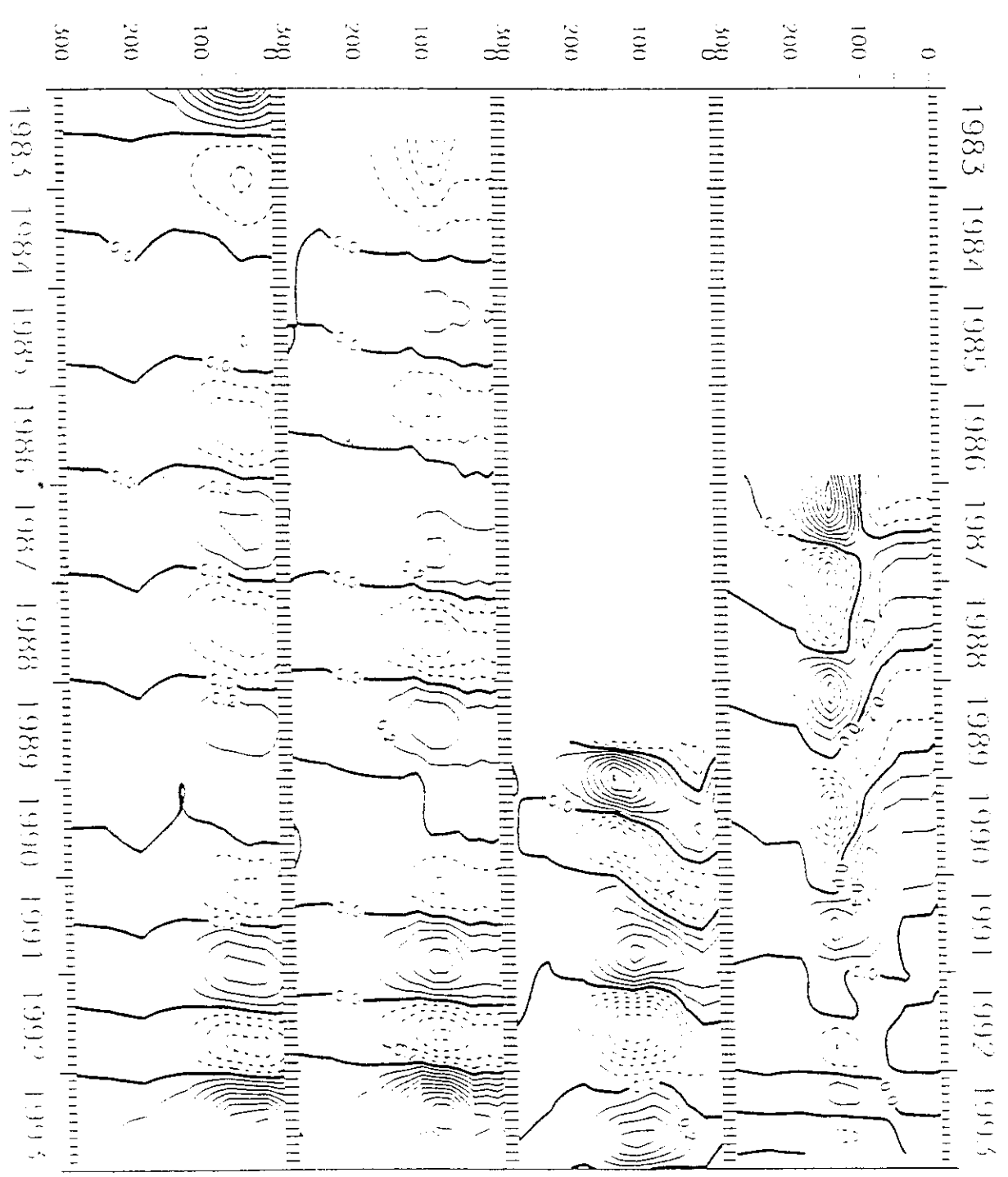
Correl of Rainfall and U at 5S-9N



CORRELATION OF SST AND RAINFALL

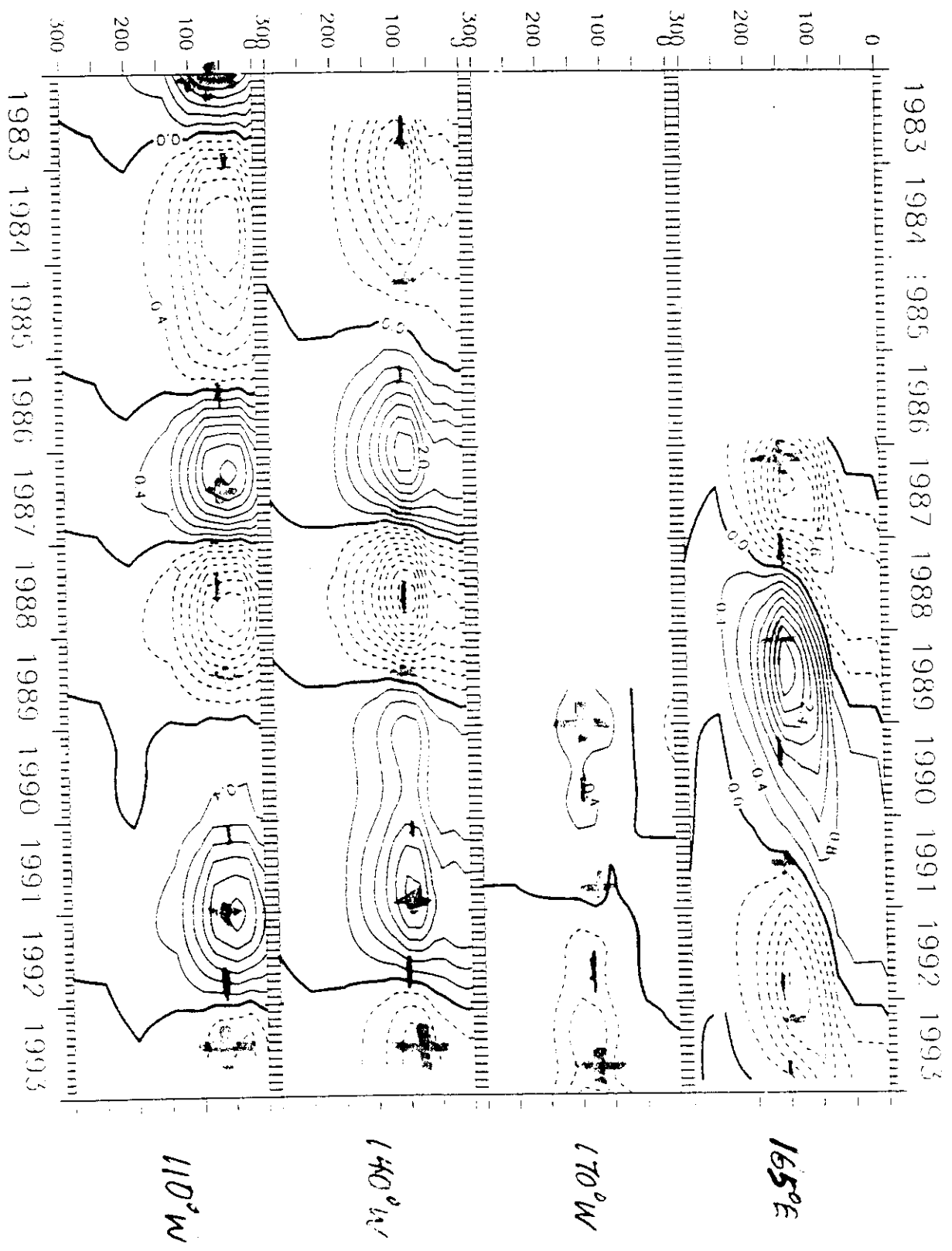


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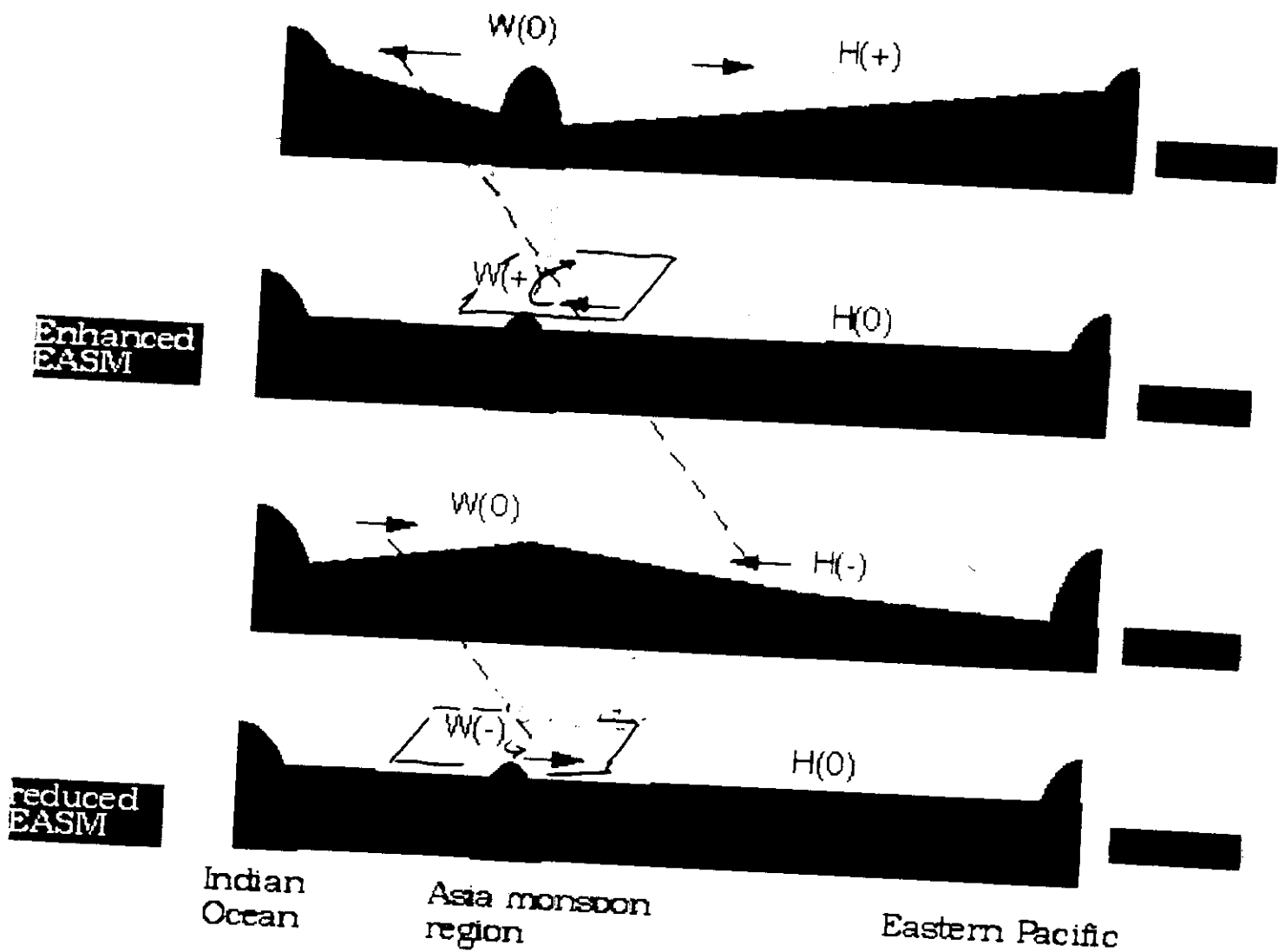


Pc1

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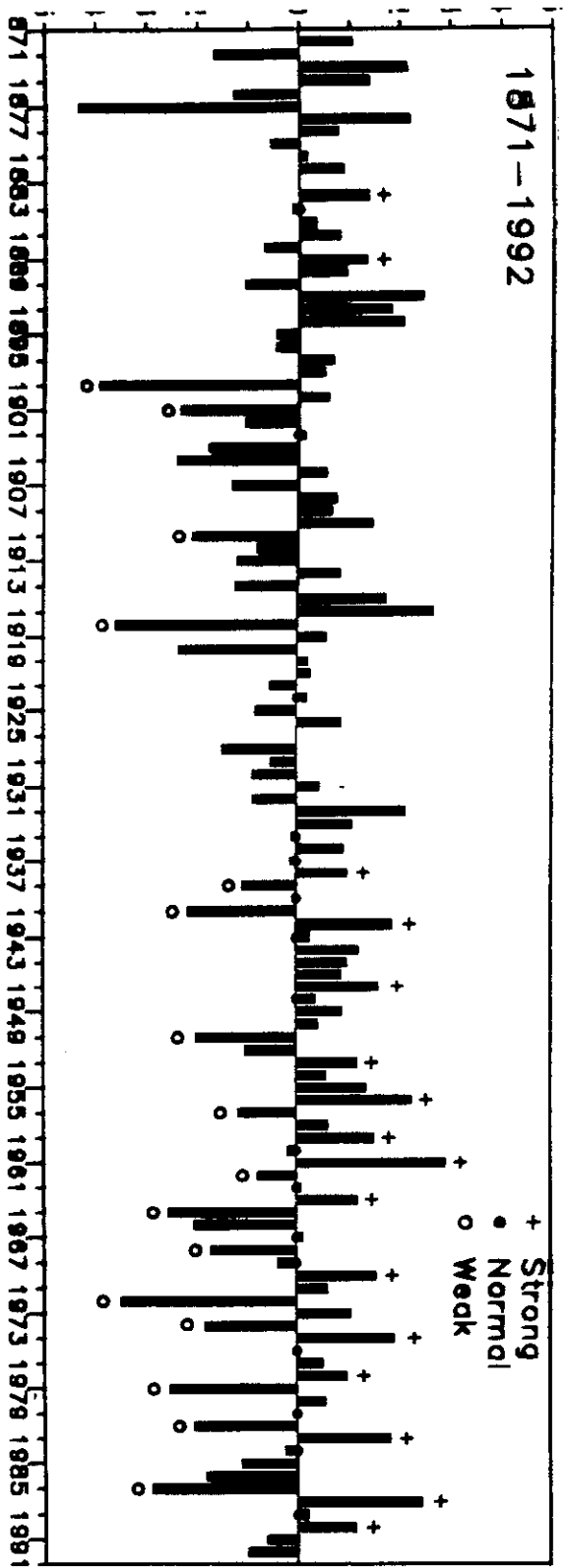


The EASM-Tropical SST Biennial Rhythm

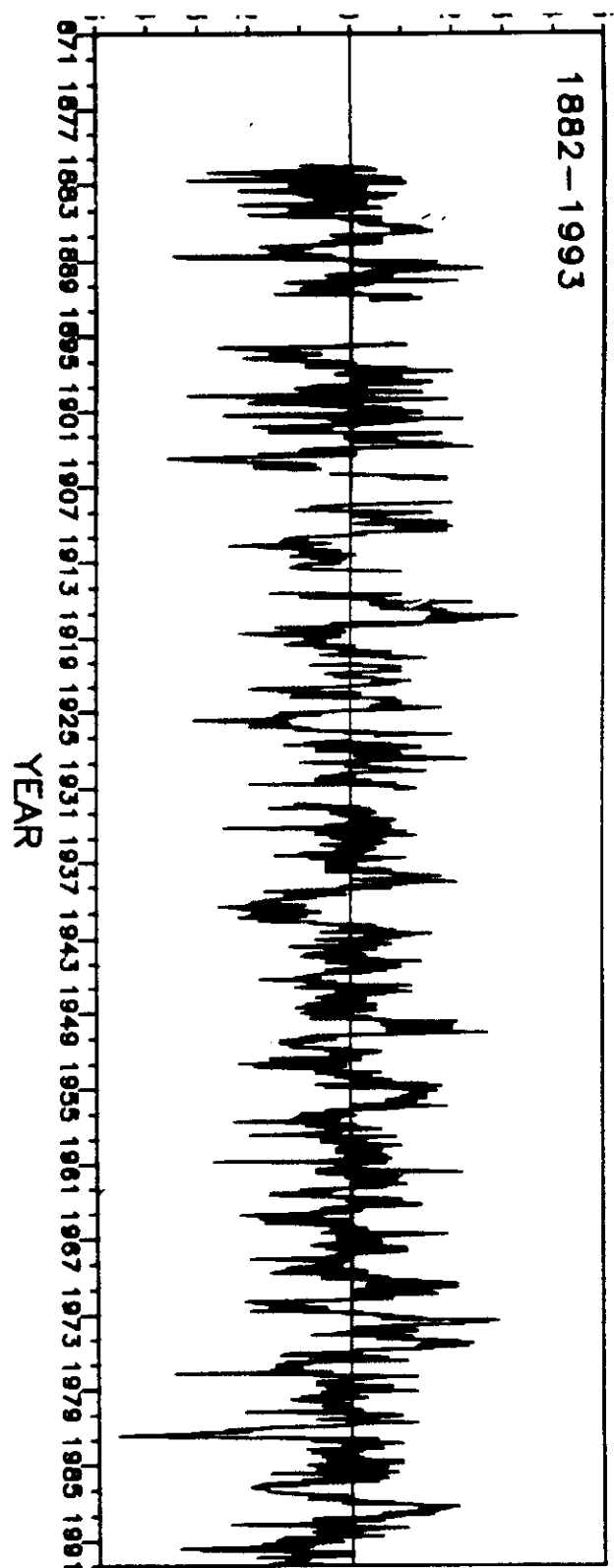


Shen & Lau (1995)

(a) Normalized Indian Monsoon Index



(b) Monthly Southern Oscillation Index



Auto-correlations of SOI for Weak Monsoon

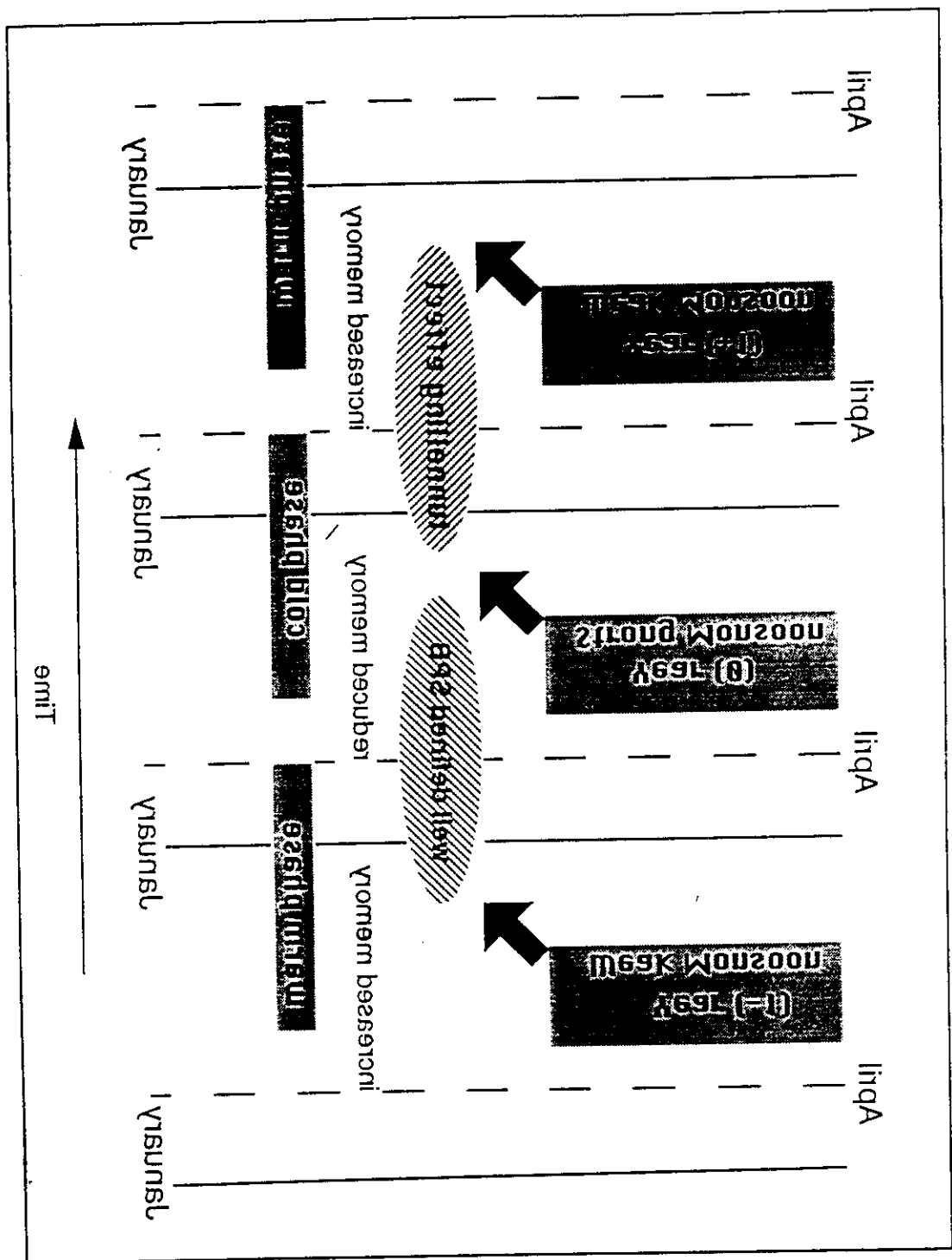
	M	A	M	J	J	A	S	O	N	D	J	F	M
Mar													
Apr													
May													
Jun													
Jul													
Aug													
Sep													
Oct													
Nov													
Dec													
Jan													
Feb													
Mar													
Apr													
May													
Jun													
Jul													
Aug													
Sep													
Oct													
Nov													
Dec													
Jan													
Feb													
Mar													

Low & High
 (0.25m2 @ 1000)

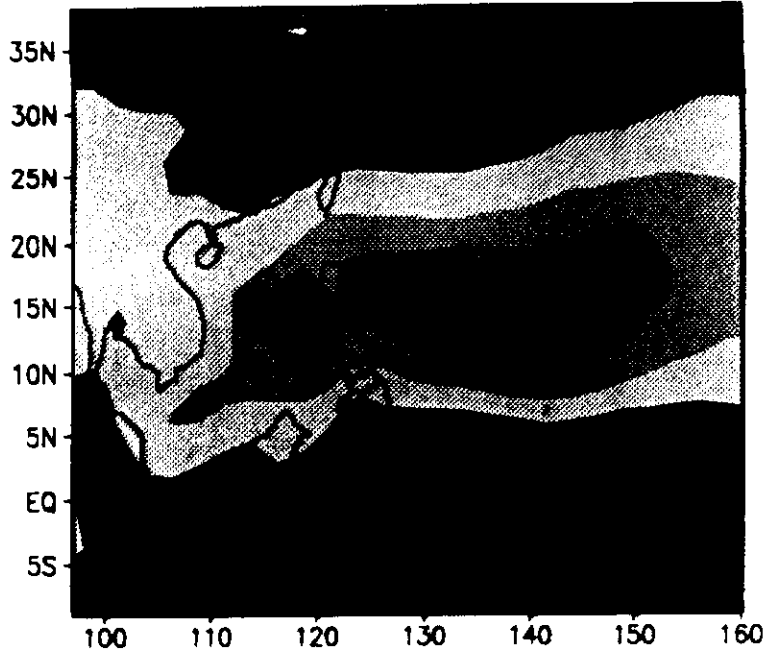
Auto-correlations of SOI for Strong Monsoon

	M	A	M	J	J	A	S	O	N	D	J	F	M
Mar	•												
Apr	29	•											
May	-1	8	•										
Jun	2	21	22	•									
Jul	38	60	28	41	•								
Aug	35	50	48	43		•							
Sep	12	24	22	33	41		•						
Oct	45	45	36	43	50		53	•					
Nov	5	21	-2	23	15	39	62	23	•				
Dec	-16	40	19	43	33	48	63	34	67	•			
Jan	-46	44	11	27	38	27	34	19	39	24	•		
Feb	-11	-12	33	55	12	46	67	38	48	34	30	•	
Mar	18	18	-1	60	9	32	49	45	67	51	27	69	•
Apr		-22	-10	9	-11	10	39	25	53	54	36	52	54
May			-31	-18	-13	9	42	-18	61	38	26	29	43
Jun				9	26	16	22	-11	63	62	64	29	26
Jul					6	-29	-26	-31	-2	7	13	2	-11
Aug						-53	-21	-33	5	24	17	7	19
Sep							3	-30	46	32	17	32	41
Oct								-7	58	64	39	29	29
Nov									43	56	40	26	19
Dec										-19	-22	-27	28
Jan											32	36	55
Feb												-6	6
Mar													-3

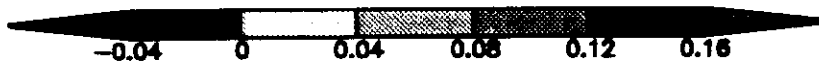
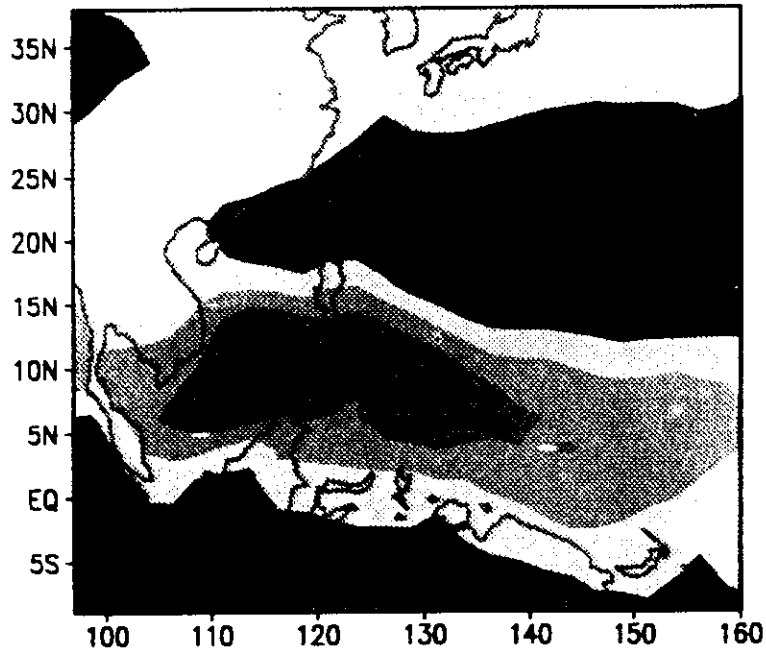
*only
-7 months*



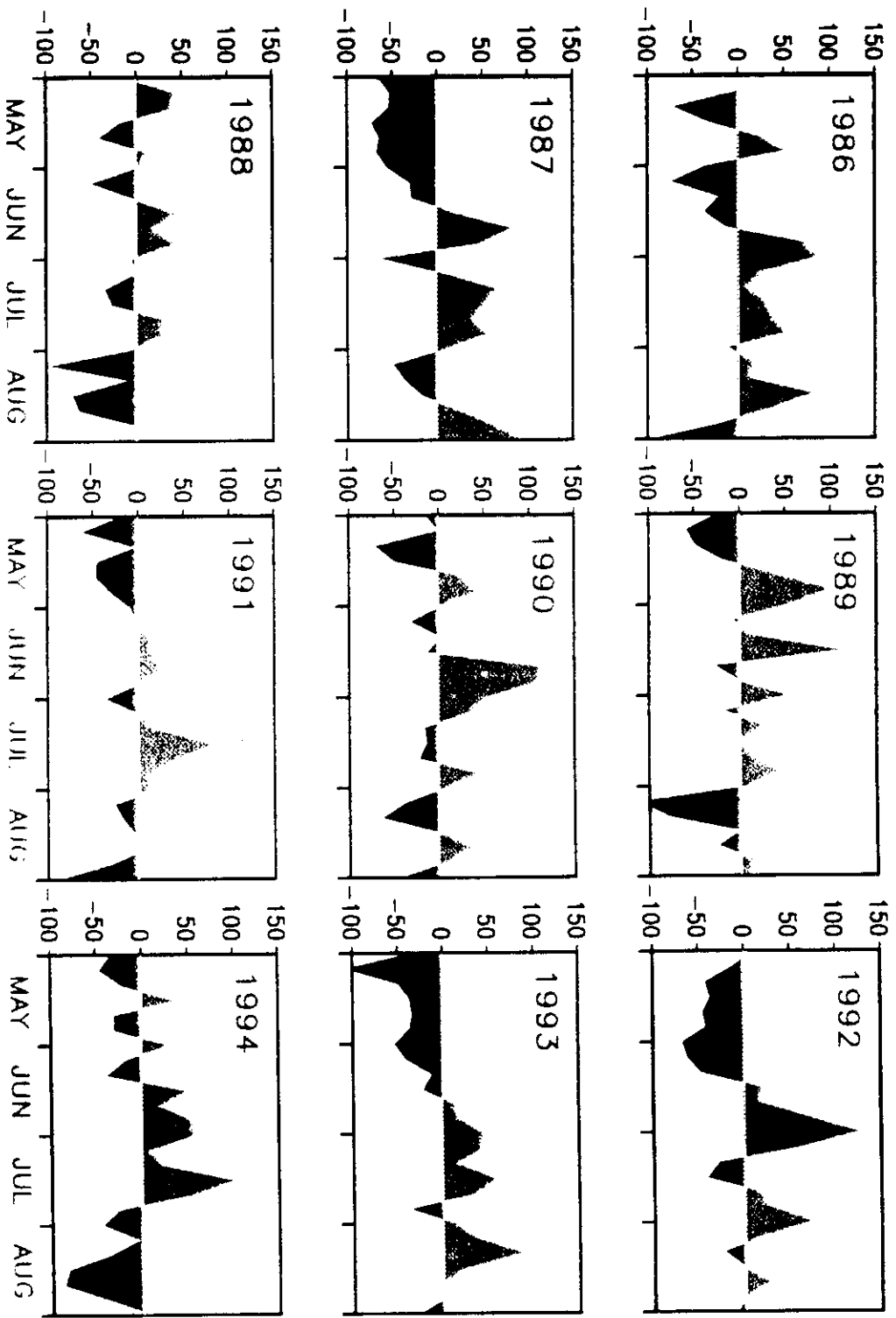
(a) EOF1 5-Day GPI (17%)



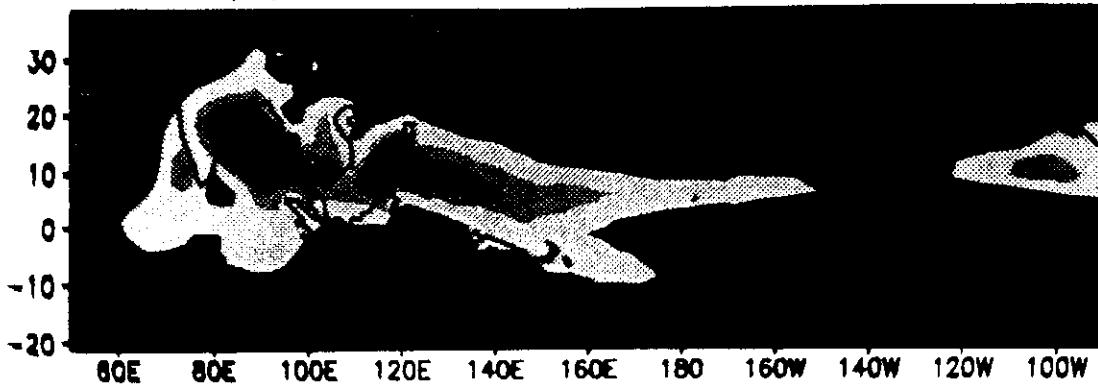
(b) EOF2 5-Day GPI (9%)



PC2 of 5-Day GPI (1986-1994)



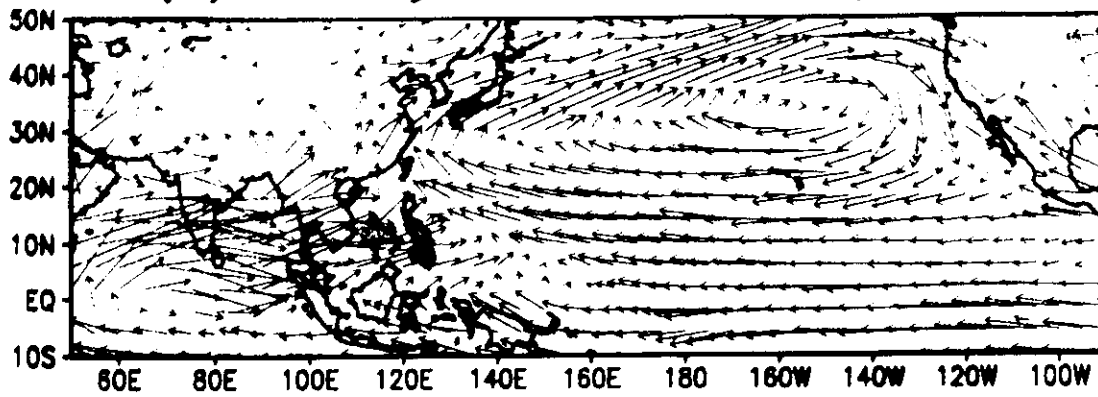
(a) 5-Day GPI (Positive PC2)



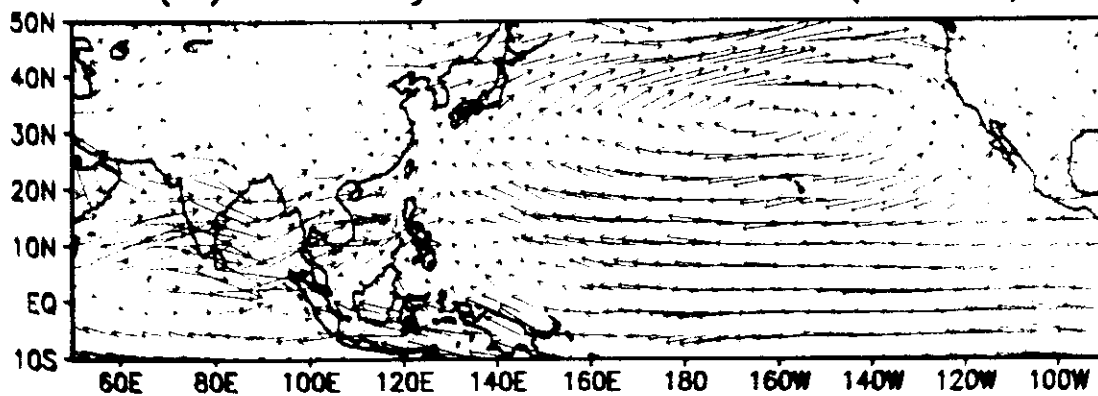
(b) 5-Day GPI Diff (NPC2-PPC2)



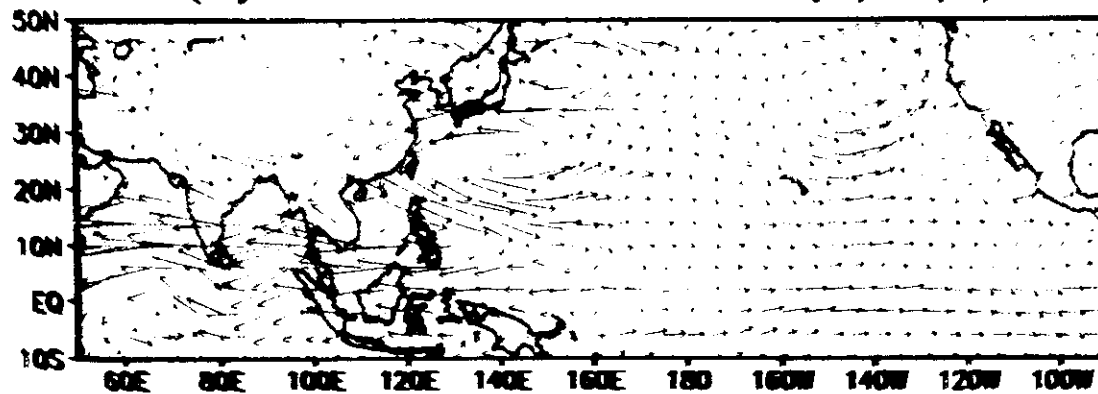
(a) 5-Day 850mb Wind (PPC2)



(b) 5-Day 850mb Wind (NPC2)

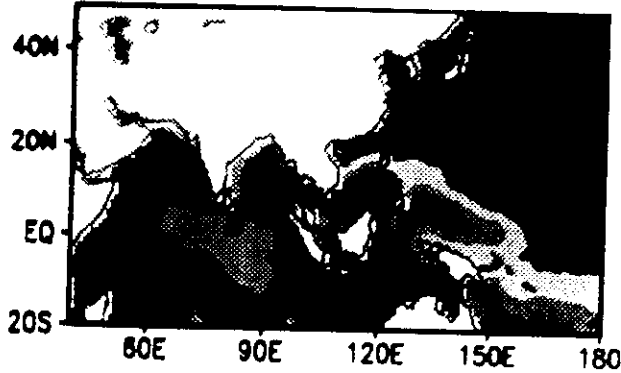


(c) 850mb Wind Diff: (b)-(a)

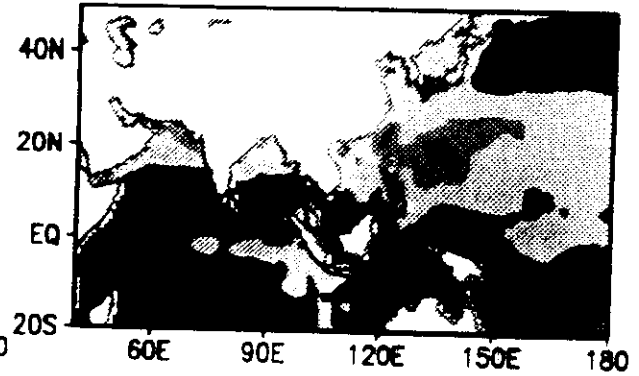


Correlations (GPI PC2 & SST)

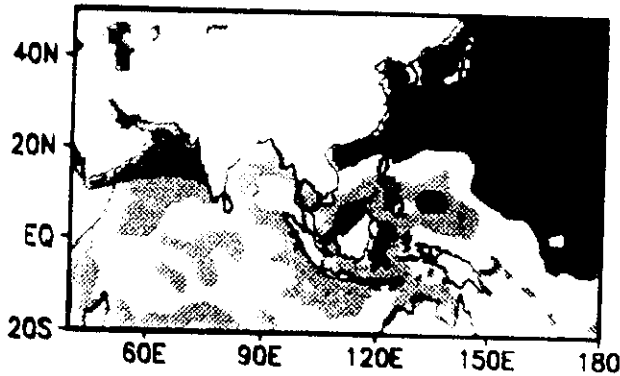
(a) Pentad -6



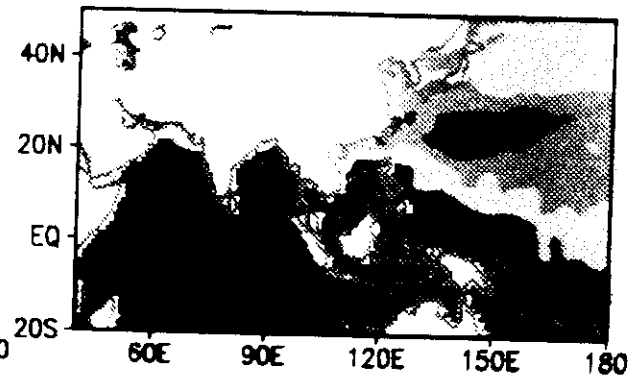
(d) Pentad 0



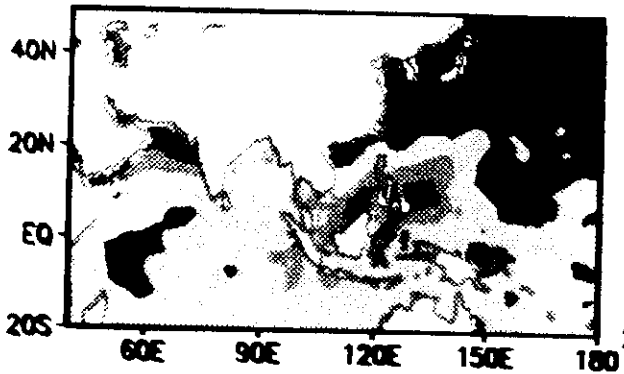
(b) Pentad -4



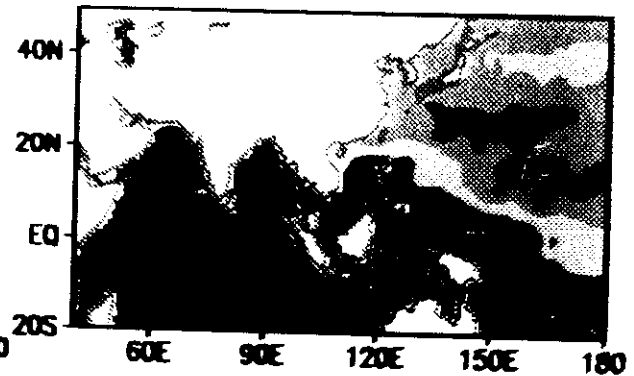
(e) Pentad +2



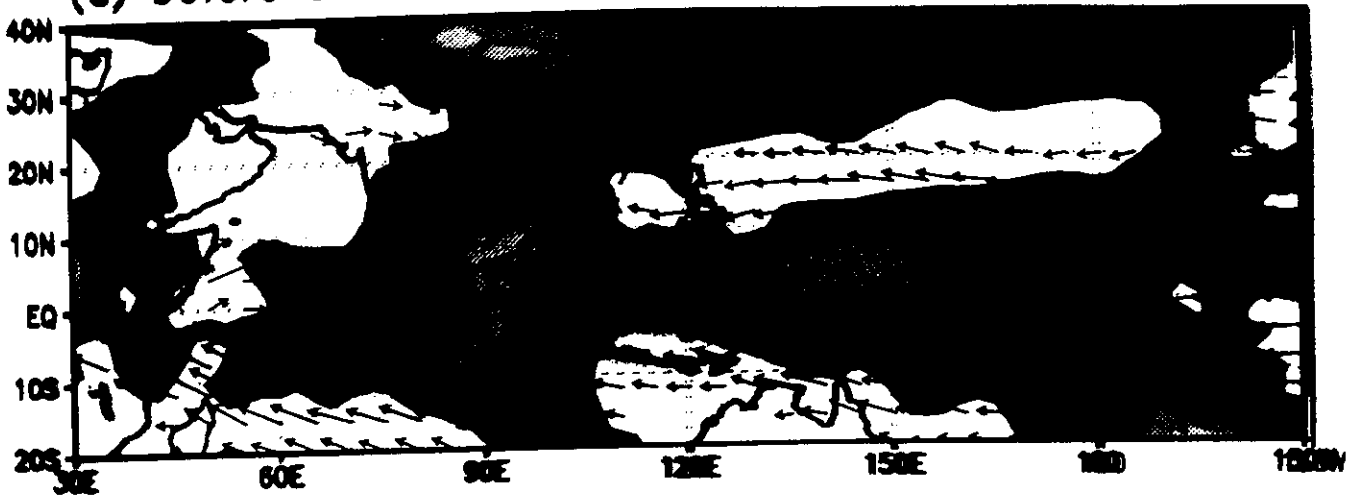
(c) Pentad -2



(f) Pentad +4



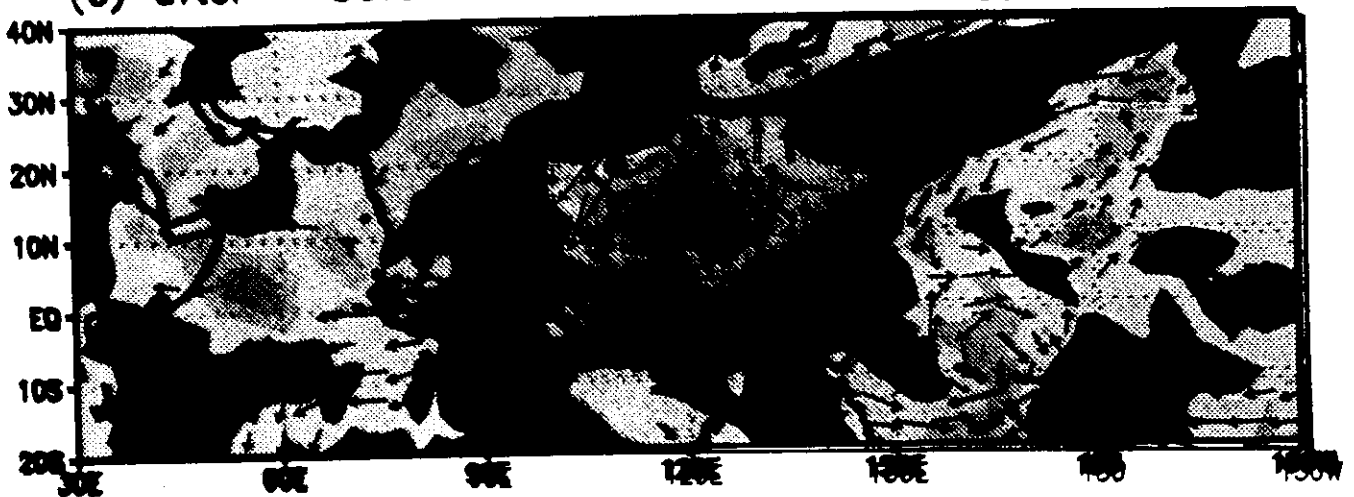
(a) before South China Sea Monsoon onset



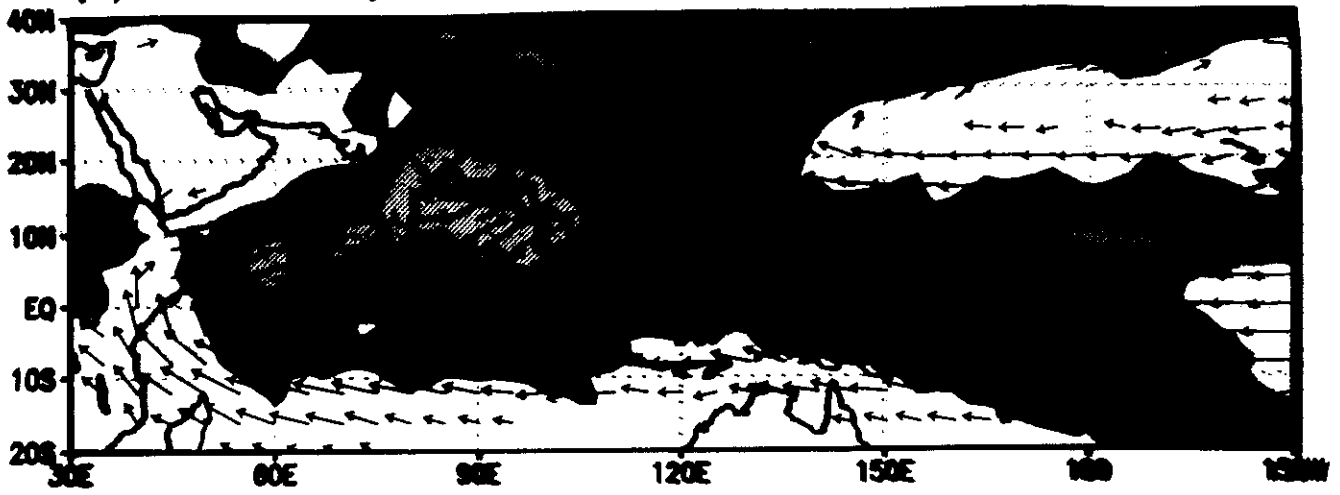
(b) after South China Sea Monsoon onset



(c) after - before South China Sea Monsoon onset



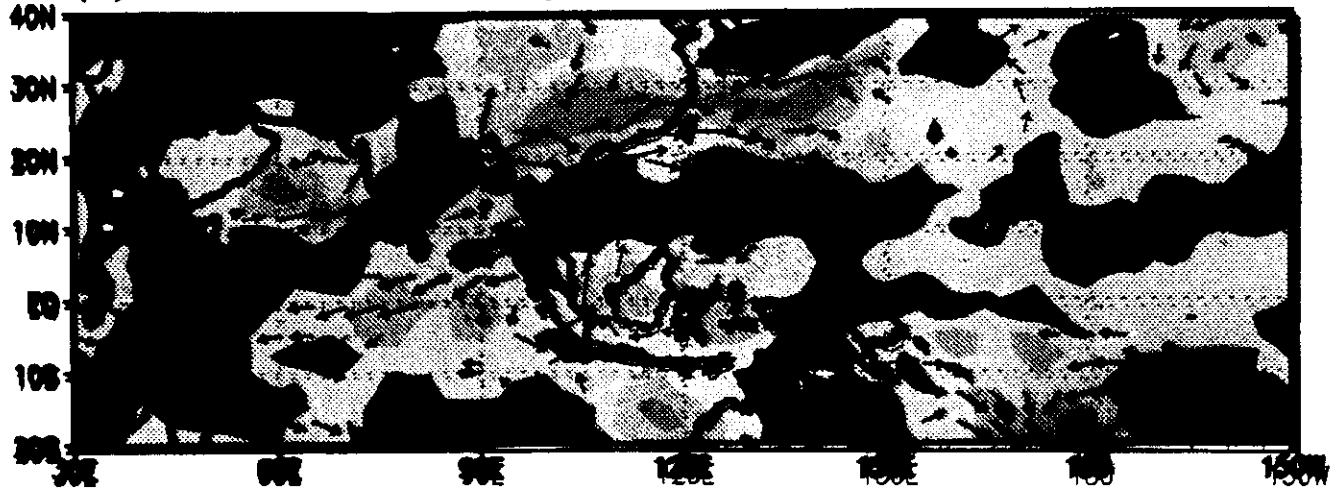
(a) before Meiyu onset



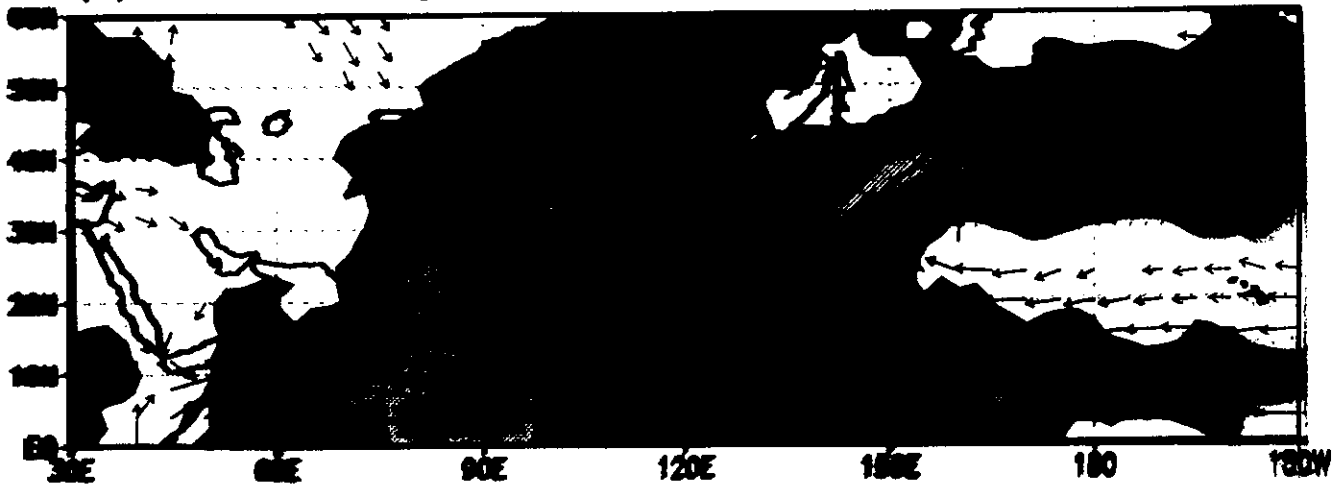
(b) after Meiyu onset



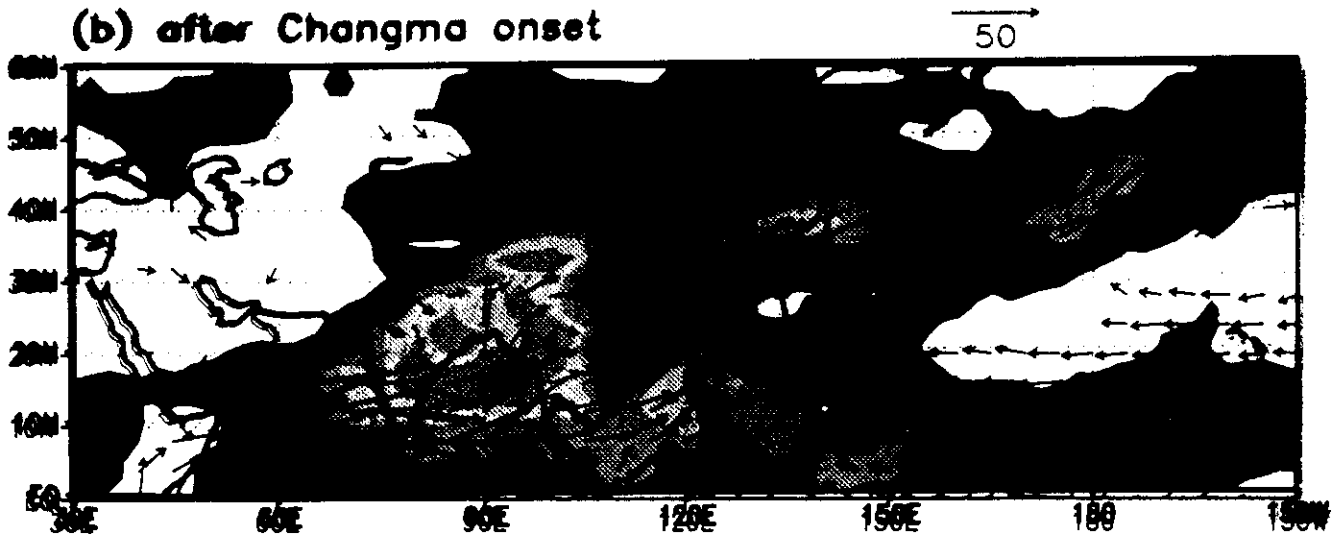
(c) after - before Meiyu onset



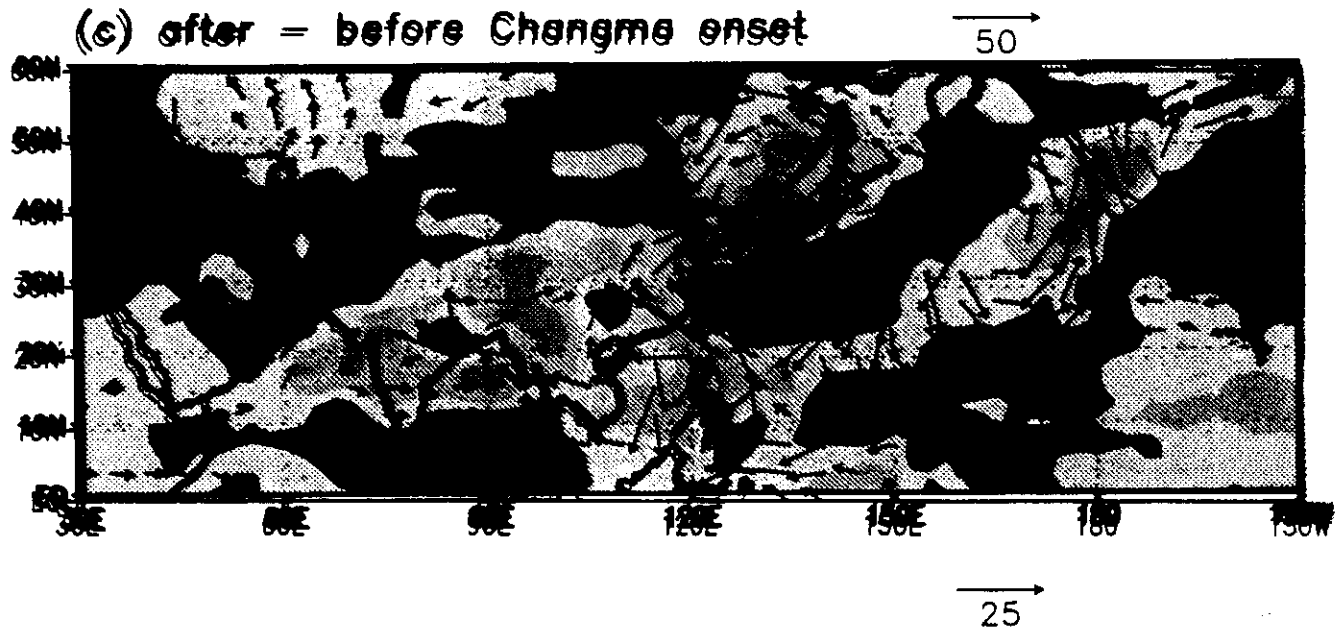
(a) before Changma onset



(b) after Changma onset



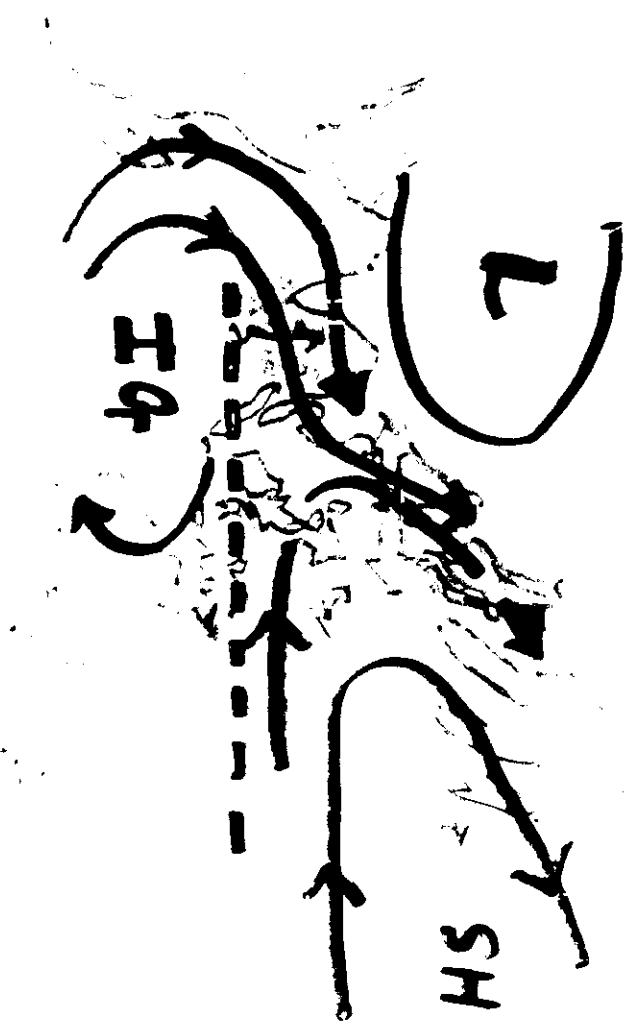
(c) after = before Changma onset

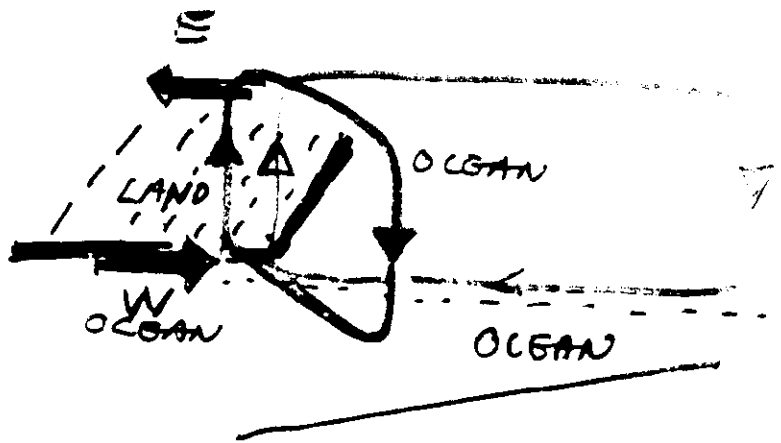


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2005-07-25

An Inter-monsoon Push-Pull System





Evaporability, β

$$E = \frac{P \epsilon e_s - e_m}{P_s r_n + r_{at}}, \quad E_p = \frac{P \epsilon e_s - e_m}{P_s r_n}$$

$$\beta = \frac{\sum E}{\sum E_p}$$

$$E_{\text{land-decoupled}} = E_p \beta$$

Experiments

1. ALO: interactive land, observed SSF
2. AO: decoupled land, observed SSF
3. AI: interactive land, climatological SSF
4. A: decoupled land, climatological SSF

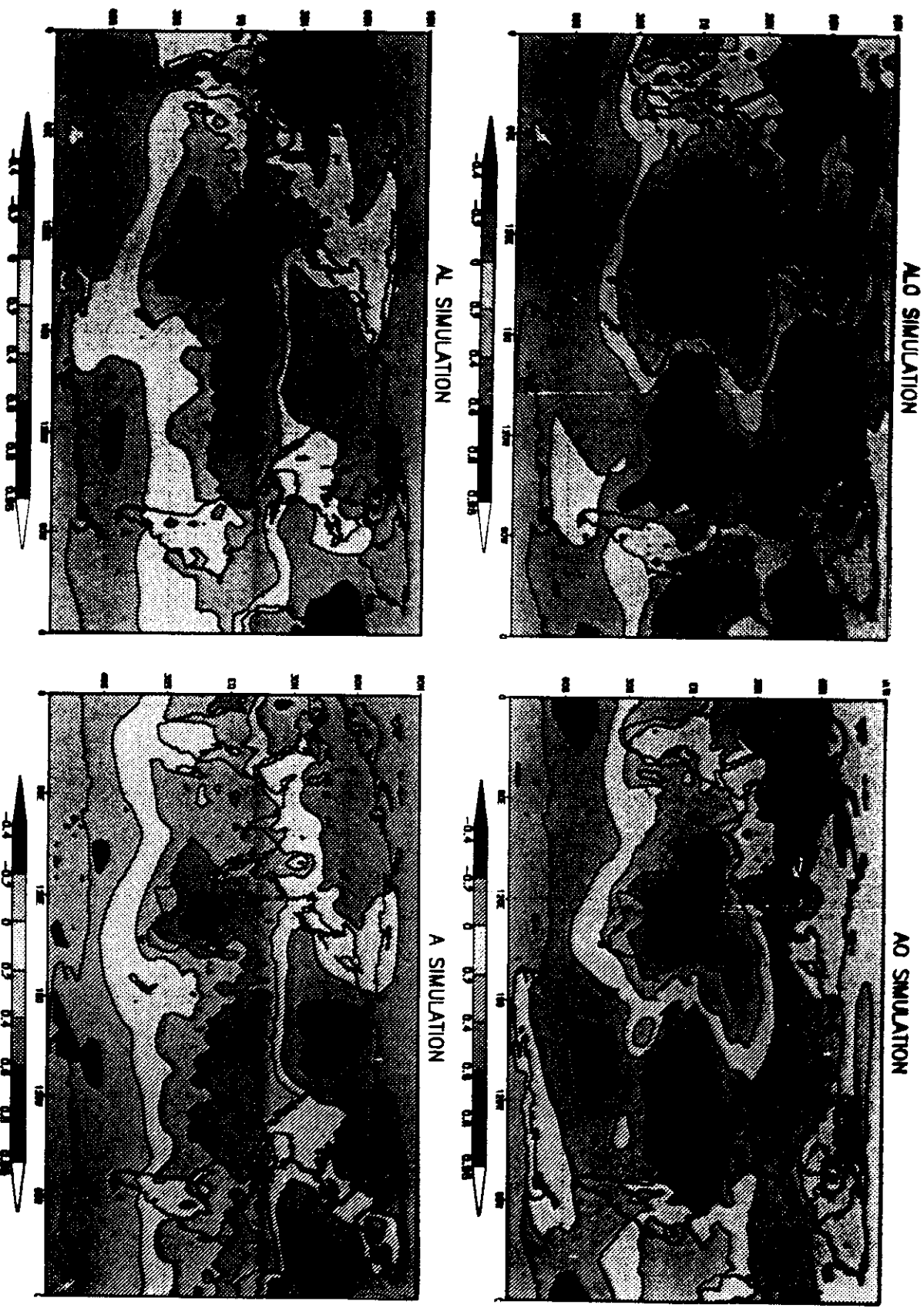


Figure 9b Global grid point correlation of monthly mean sea level pressure at four points closest to Darwin, Australia (131E, 11S) for Aries/GEOS simulations. Contour interval 0.2, with values given by color bar.

$U = 0.85 \text{ m/s} - 0.2 \text{ m/s}$

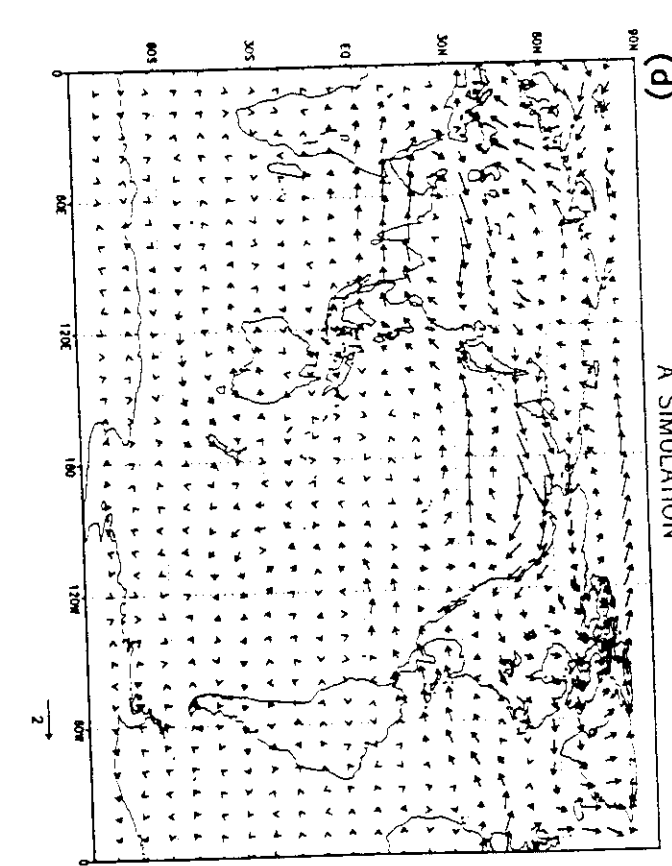
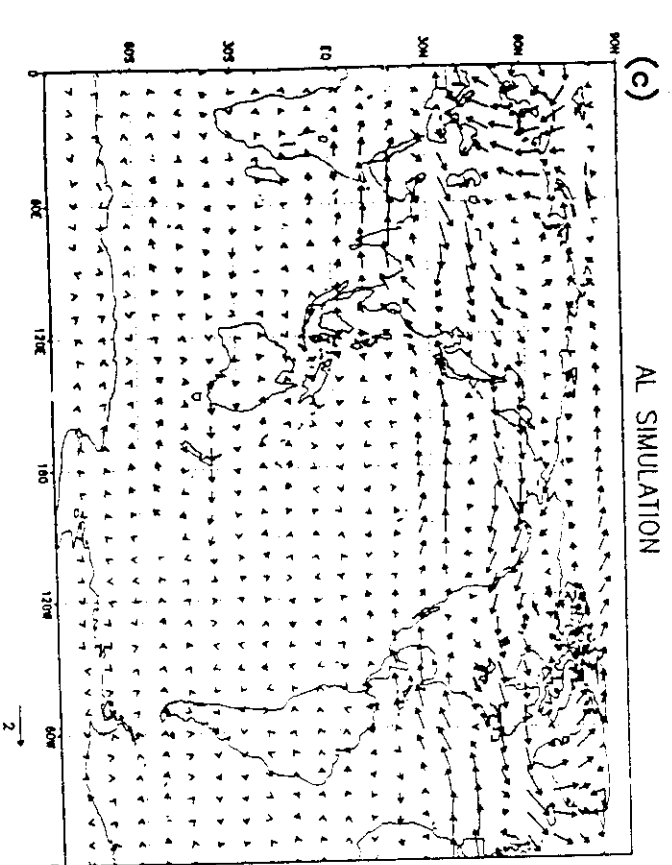
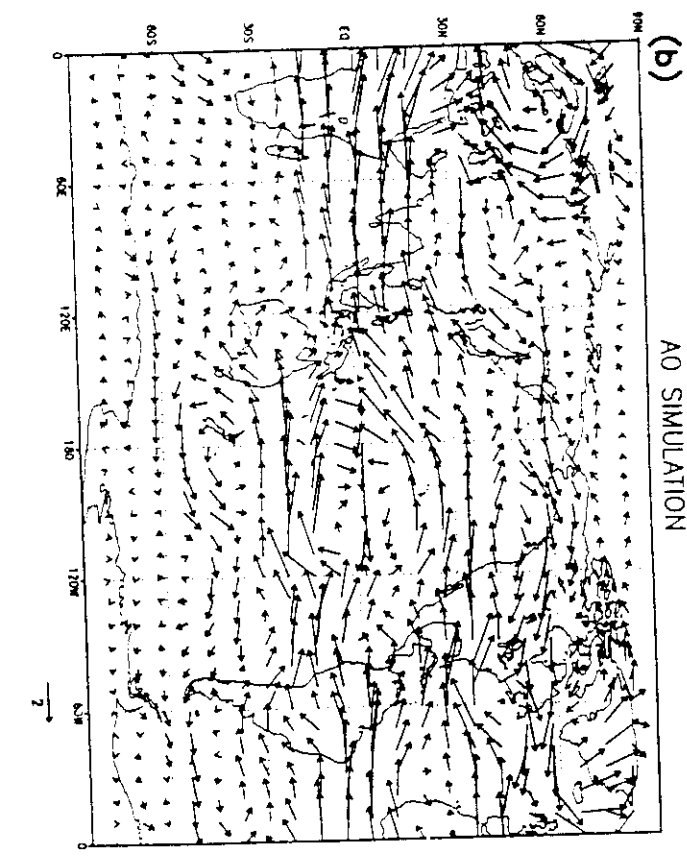
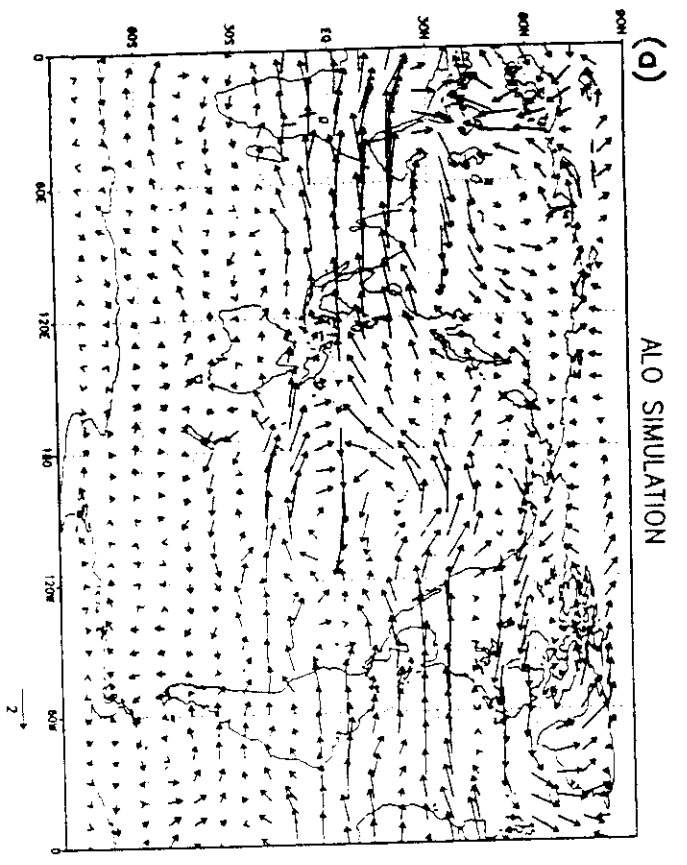
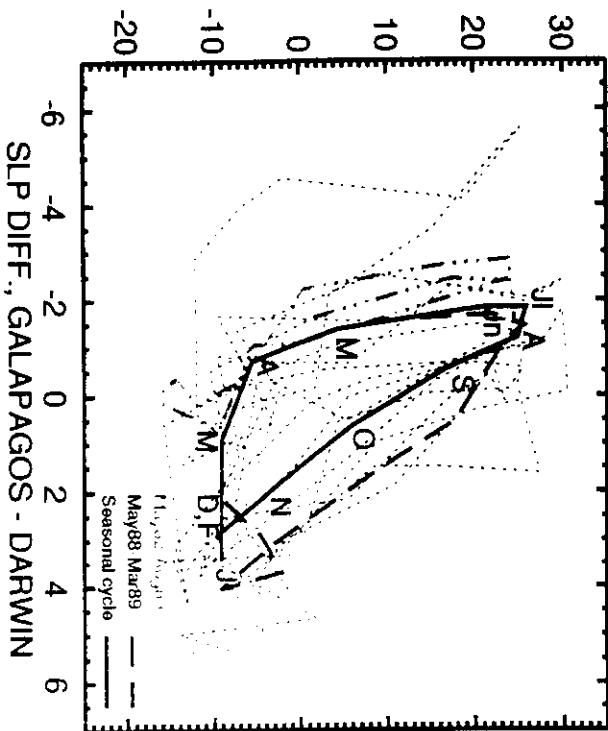
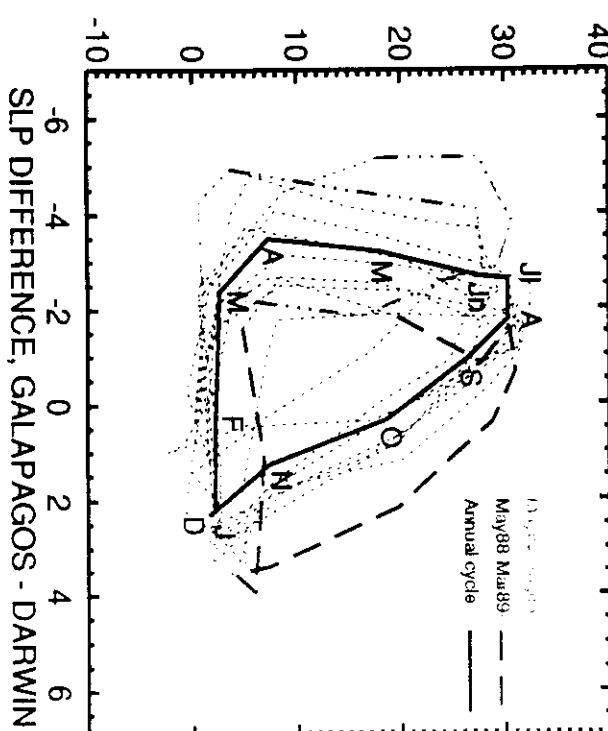


FIGURE 10

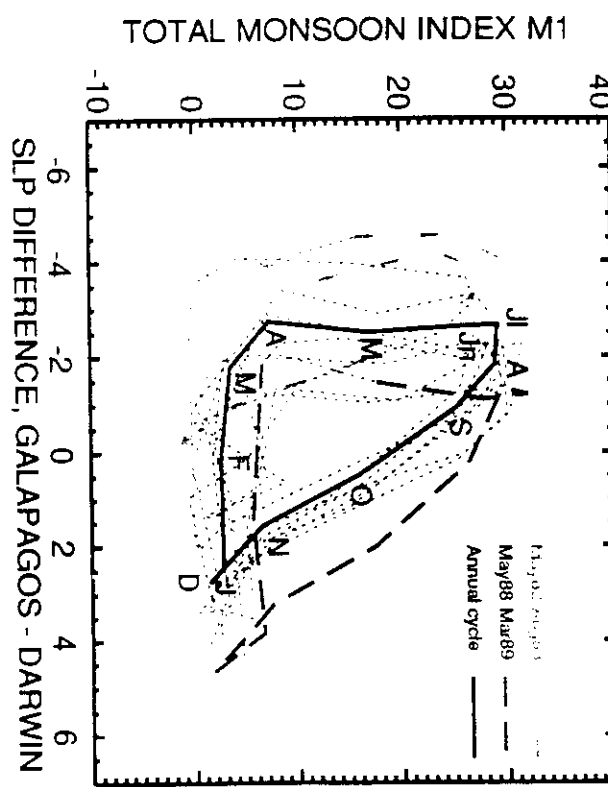
(a) TOT. CLIM. TRAJ., OBSERV.



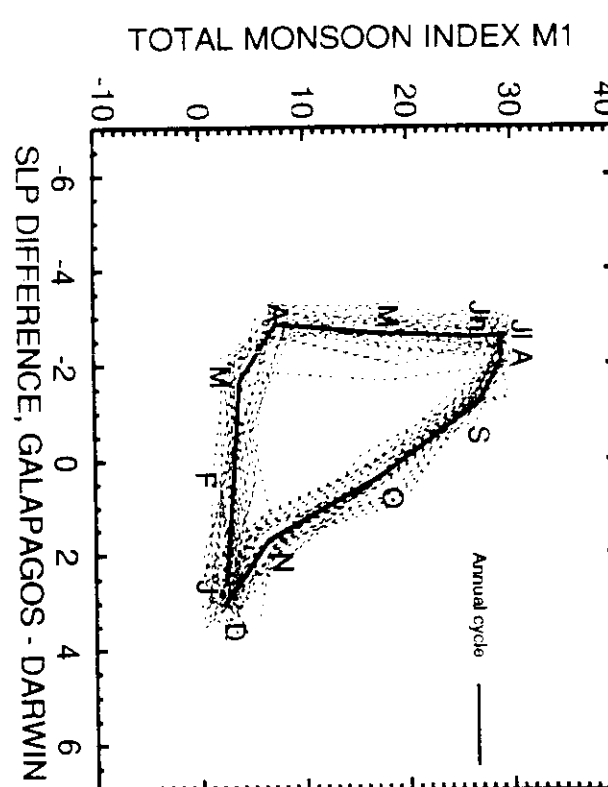
(c) TOT. CLIM. TRAJ., AO



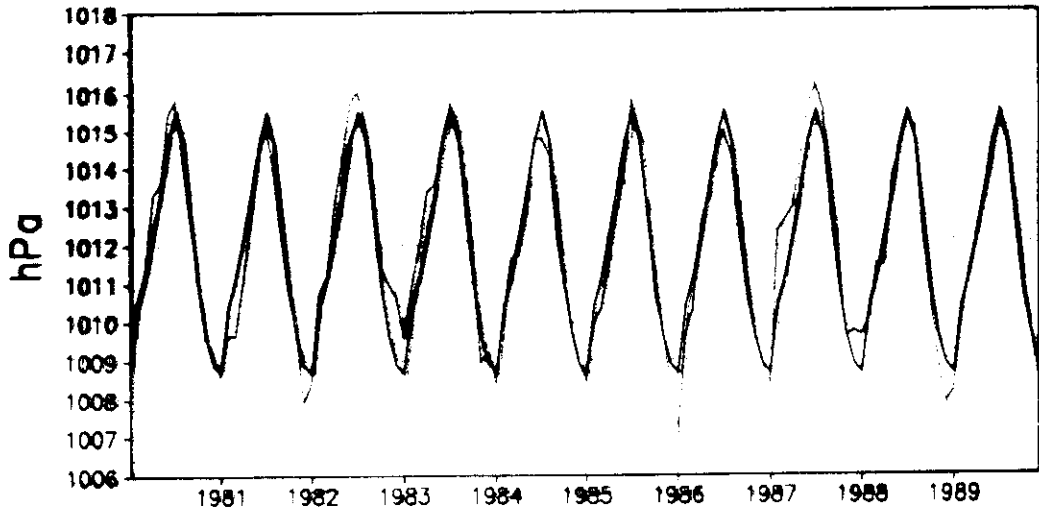
(b) TOT. CLIM. TRAJ., ALO



(d) TOT. CLIM. TRAJ., AL

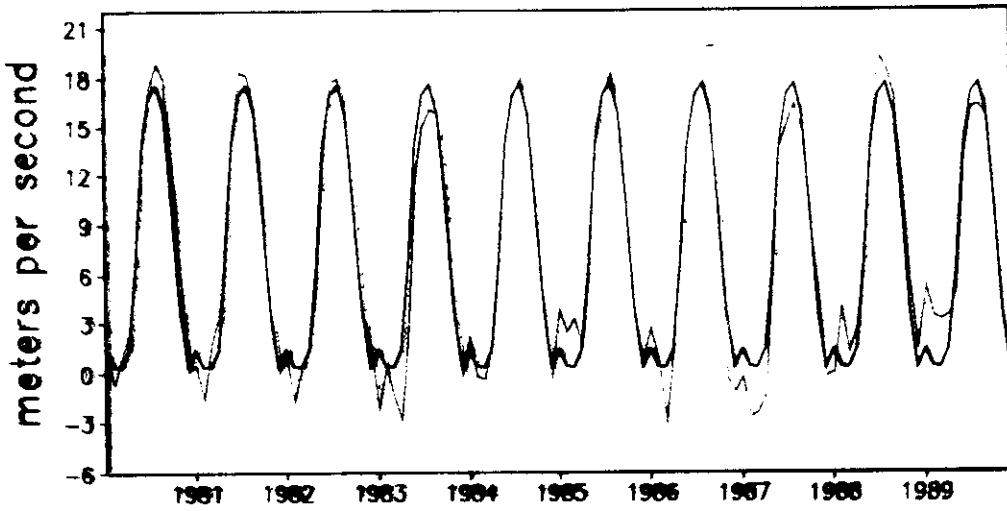


DARWIN SLP TIME SERIES, ALO



SIMULATED YEAR (with reference to SST forcing)

M1 (-200 hPa zonal wind), ALO



SIMULATED YEAR (with reference to SST forcing)

(a)



ALO-AO MN. PREC. DIFF. (MM)

(c)



ALO-AO BETA (EVAPORABILITY) DIFF. (MM)

(b)



ALO-AO MN. SFC. TEMP. DIFF. (MM)

(d)



ALO-AO MN. EVAP. DIFF. (MM)

(b)



AL-A MN. SPEC. HUMID. DIFF. (MM)

(c)



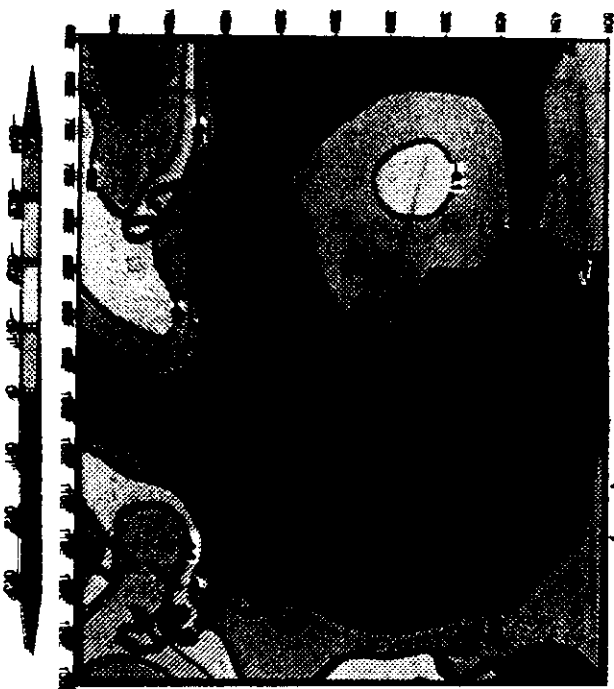
AL-A BETA (EVAPORABILITY) DIFF. (MM)

(a)



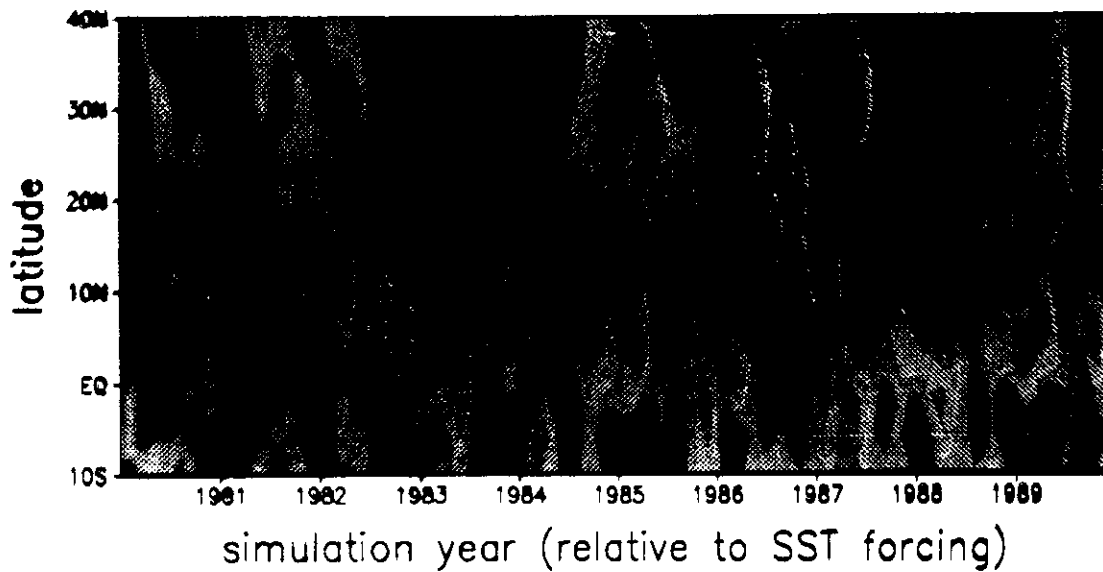
AL-A MN. SPEC. HUMID. DIFF. (MM)

(d)



AL-A MN. EVAP. DIFF. (MM)

ZONAL AVG. PREC., ALO-AO, 100-130E



ZONAL AVG. PREC., AL-A, 100-130E

